Vehicle Fuel Consumption

Overview

The data for aggregate 2013 vehicle fuel consumption for cities and towns in SLED were derived through an analytical process performed by the National Renewable Energy Laboratory (NREL). This process estimated fuel consumption by integrating publicly and commercially available datasets at various spatial resolutions describing traffic intensity, vehicle fuel economy, and regional fuel consumption totals. Table 1 below outlines the source and characteristics of datasets used by NREL. The analysis methods are described in more detail in the Methods section below and are summarized in Figure 1.

Table 1. Data Sources Used

[see xlsx]

Methods

The fundamental dataset supporting the SLED estimates of vehicle fuel is the Federal Highway Administration (FHWA) Highway Performance Monitoring System (HPMS) Shapefiles. These data provide a highly spatially resolved estimate of traffic intensity across the US. Specifically, they include estimates of the total annual vehicle miles traveled (VMT) mapped to individual, geolocated road segments. NREL combined these data with average vehicle fuel economies (miles per gallon, or mpg) for representative vehicles along each road segment to estimate the fuel consumption associated with the reported traffic, following Equation 1:

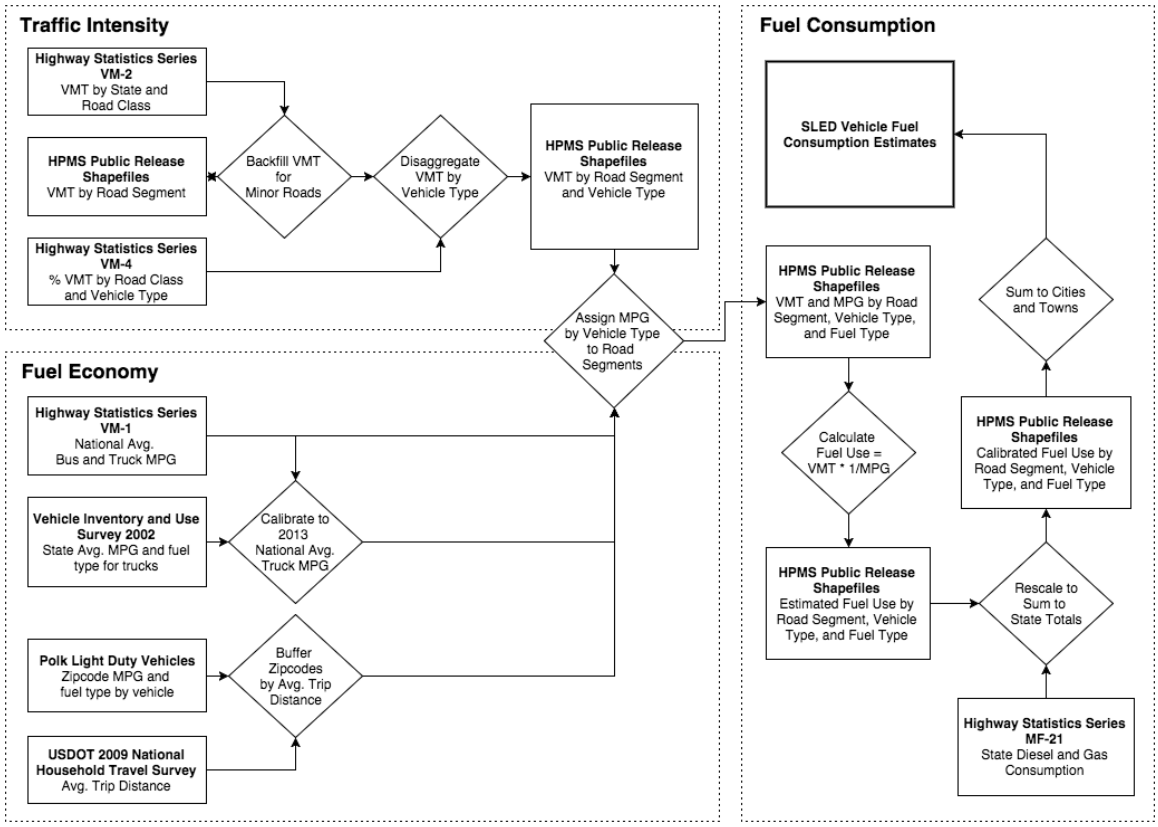
$$Fuel\ Consumption = VMT * 1/MPG$$

In order to determine representative fuel economy for each road segment in the HPMS dataset, NREL integrated several ancillary datasets on traffic intensity and fuel economy. First, NREL used the FHWA Highway Statistics Series VM-2 and VM-4 datasets, respectively, to backfill missing VMT data for minor road classes and disaggregate VMT along road segments by vehicle type (e.g., passenger cars, light trucks, etc.). Next, NREL integrated a series of sources describing vehicle fuel economies and fuel types for different classes of vehicles, including Polk Light Duty Vehicles for passenger cars and light trucks, US Census Bureau Vehicle Use and Inventory Survey (VIUS) for single-unit and combination trucks, and FHWA Highway Statistics Series VM-1 for buses. For the Polk Light Duty dataset, which is resolved at zip code, NREL applied average trip distance estimates from the USDOT Bureau of Transportation Statistics to assign vehicles from zip codes to nearby road segments, and calculate localized estimates of average mpg and proportions of vehicles by fuel type (diesel and gas). From the latter two datasets, NREL derived regional (state and national, respectively) estimates of average fuel economy and proportions of vehicles by fuel type (diesel and gasoline), which NREL then applied to all roads by region.

Using this combination of ancillary data, NREL produced a refined version of the HPMS road segments that included estimates of both VMT and average fuel economy, segmented by vehicle type and fuel type. NREL applied Equation 1 to these refined data to estimate the fuel consumption by vehicle and fuel type along each road segment, and then used linear rescaling to calibrate the estimates to sum exactly to the reported total state vehicle fuel consumption totals for diesel and gasoline (FHWA Highway Statistics Series MF-21). Finally, for the purposes of reporting in SLED, NREL summed total fuel consumption by fuel type to the aggregate level of cities and towns.

This analysis drew heavily on the methodology developed by Gately et al. (2015) and shares several core datasets, assumptions, and methods; however, the work performed by NREL diverges in a few key areas. First, for reasons outlined in their work, Gately et al. (2015) calculated their results natively at the county level. As a result, subcounty (e.g., city or town) level results require additional methods and assumptions for spatial disaggregation. In contrast, because NREL's results are resolved down to individual road segments, they can be easily summarized at a variety of spatial resolutions. Secondly, whereas Gately et al. (2015) used national average fuel economies for all road segments, NREL's method used regionally and locally resolved estimates of fuel economies to capture greater spatial variation in the composition of vehicles. Finally, to calibrate fuel estimates along road segments to reported state totals, Gately et al. (2015) applied a sophisticated optimization routine that allowed for small adjustments in various measures. For this same goal, NREL simply linearly rescaled road segment fuel consumption totals to precisely match the state totals.

Figure 1. Summary of Methods


Traffic Intensity
Highway Statistics Series VM-2
VMT by State and Road Class
HPMS Public Release Shapefiles
VMT by Road Segment
Highway Statistics Series VM-4
% VMT by Road Class and Vehicle Type
Backfill VMT for Minor Roads
Disaggregate VMT by Vehicle Type
HPMS Public Release Shapefiles
VMT by Road Segment and Vehicle Type
Assign MPG by Vehicle Type to Road Segments
Fuel Economy
Highway Statistics Series VM-1
National Avg. Bus and Truck MPG
Vehicle Inventory and Use Survey 2002
State Avg. MPG and fuel type for trucks
Calibrate to 2013 National Avg. Truck MPG
Polk Light Duty Vehicles
Zipcode MPG and fuel type by vehicle
Buffer Zipcodes by Avg. Trip Distance
USDOT 2009 National Household Travel Survey
Avg. Trip Distance
Fuel Consumption
SLED Vehicle Fuel Consumption Estimates
HPMS Public Release Shapefiles
VMT and MPG by Road Segment, Vehicle Type, and Fuel Type
Calculate Fuel Use = VMT * 1/MPG
HPMS Public Release Shapefiles
Estimated Fuel Use by Road Segment, Vehicle Type, and Fuel Type
Rescale to Sum to State Totals
Highway Statistics Series MF-21
State Diesel and Gas Consumption
HPMS Public Release Shapefiles
Calibrated Fuel Use by Road Segment, Vehicle Type, and Fuel Type
Sum to Cities and Towns

References Cited

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